
CENTRAL EXPERIMENTAL FARM.

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DEPARTMENT OF AGRICULTURE,
OTTAWA, . . . CANADA.

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BULLETIN No. 10.

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Treatment of Apple Scab, Grape and
Gooseberry Mildew.

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APRIL, 1891.

To the Honourable

The Minister of Agriculture.

SIR,—I beg to submit for your approval the tenth bulletin of the Central Experimental Farm, which has been prepared under my direction by Mr. John Craig, Horticulturist of the Central Experimental Farm.

The alarming spread of fungoid diseases on fruits during the past few years, and the serious losses resulting therefrom have awakened much interest in this subject among fruit growers, both in Canada and the United States. The simple and practical remedies recommended in this bulletin for several of the most troublesome of these parasitic growths, based on experience, both at the Department of Agriculture in Washington and at the Experimental Farm in Ottawa will, I trust, be thoroughly tested by those engaged in the cultivation of the apple, grape and gooseberry, and, if used in accordance with the directions given, there is every reason to believe that the treatment will be successful.

I have the honour to be

Your obedient servant,

WM. SAUNDERS,

Director Experimental Farms.

OTTAWA, 25th April, 1891.

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TREATMENT
OF
APPLE SCAB, GRAPE AND GOOSEBERRY MILDEW,

BY
JOHN CRAIG,

Horticulturist of the Central Experimental Farm.

The spread and development of the disease, known as "apple scab" and "black spot" of the apple (*Fusicladium dendriticum* Eckl), has been so gradual, during the past ten or fifteen years, that orchardists do not at the present time fully grasp the magnitude of the annual loss from this cause to the fruit interests of the Dominion. While the prevalence of the malady is not always constant in the same locality, yet it is spreading each year and extending its ravages to varieties hitherto unaffected. It is true that many varieties are comparatively exempt, yet we cannot expect "fungous proof apples," except in a relative degree.

This disease is not of recent introduction, nor is it confined to America alone. It is severest in the northern and cooler regions; but as it is in these districts that the bulk of our apples is produced, it becomes the more important that orchardists and fruit-growers should look closely into the subject of suitable remedies.

Many orchards of Fameuse that ten years ago yielded 60 to 75 per cent. of first-class apples do not now give more than 25 or 30 per cent., and the remainder "seconds" or "thirds."

The late Mr. Charles Gibb* stated to the Montreal Horticultural Society that in his orchard, which was more completely exposed to the prevailing winds, and in which the disease was more pronounced than in any other orchard in that locality, the effect was so marked that his apples brought an average of only 25 cents per bushel, or

*Report of Montreal Horticultural Society, 1886-87, page 21.

62 cents per barrel. If free from spot the same variety would have sold readily for 75 cents per bushel. Out of 15 barrels he had:—

| | |
|--------------------|---------|
| First-class | 0 bbls. |
| Second-class | 1 " |
| Third " | 4 " |
| Fourth " | 10 " |

The reduction in value in the selling price is only one side of the question. When the loss resulting from diminished size is considered it fully equals the first source of loss, making a total direct and indirect depreciation of value, which, when compared with first-class fruit, would stand as about 1 to 4.

The importance of gaining a practical knowledge of the habits of this fungus is manifest, and it is a matter of immediate and vital interest to all fruit-growers to know that a treatment which promises to be entirely successful has been discovered, and is already being used to a considerable extent.

CAUSE OF APPLE SCAB.

The apple scab is caused by a minute parasitic fungus, a low form of plant life, which, by living on the leaf and fruit of the apple, prevents assimilation in the former and the development of the latter. It is not so generally known that the same fungus attacks both the leaves and the fruit. Prof. Scribner* says: "On the leaves the first manifestations of the presence of the parasite are the appearance here and there over the surface, of smoky olive green spots, rounded in outline. The older spots range from one-eighth to one-half an inch in diameter, or they may appear as large irregular blotches, by the running together of several of the spots first formed. They are for the most part confined to the upper side of the leaf, which often becomes much distorted through the unequal development of the two surfaces. The colour of the older spots is nearly black and their surface somewhat velvety. The growth of the young shoots is often seriously checked through the direct action of the fungus upon them, and when the foliage of a tree is much affected its nutrition must be seriously impaired. The tree is rendered less liable to withstand the severe cold of the winter season, and is rendered more likely to injury from early and late frosts." Cool damp weather is especially favourable to the develop-

* Scribner, Fungus Diseases.

* Gallie

ment of this disease, and it is during such seasons that it spreads with great rapidity. Last season was a characteristic one in this respect, so that whether the coming summer be dry or wet it may be expected that with the crop of seed, (spores) now on hand we must be prepared to fight the disease, as it will surely be more or less prevalent.

The appearance of the scab on the apple is too well known to need a minute description. When a thin section of the diseased portion of the fruit is examined by the aid of a microscope, Prof. Galloway* says that "a cluster of short brownish threads is seen arising from a darker mass of roundish cells, which are seated directly upon the healthy tissue of the fruit or the leaf, as the case may be. The free ends of the threads often bear pear-shaped bodies of nearly the same colour as the supporting threads. The pear-shaped bodies are the spores of the fungus, and it is through their agency that the parasite is propagated. The brownish threads serve merely as supports for the spores, while the dark mass of tissue constitutes the body of the fungus, or, if I may so express it, the root, branches and leaves. When full grown the spores separate readily from their supporting stalks, and being exceedingly light, are easily wafted from place to place by currents of air. In this way they reach healthy fruit and leaves, and if the proper conditions of moisture and heat are present they quickly germinate, by sending out slender tubes, which bore their way into the leaves or fruit, and ultimately give rise, just beneath the cuticle or skin, to dark masses of cells, like those already described. At first this mass of fungous tissue is entirely beneath the cuticle, but as the former continues to grow the latter is ruptured, and it is then that another crop of stalks and spores are formed. In this way the fungus continues its development throughout the growing season, the crops of spores formed in the autumn living over winter on the old leaves, fruit and young branches." And thus we have a stock of seed (spores) for next year's crop, which germinate, as already stated, when favourable conditions are found. Just as soon as the leaves begin to form in the spring they are attacked by the disease, and what is true of the leaves is also true of the fruit, spots being sometimes noticeable on the latter when little larger than peas. This emphasizes the statement that early treatment is a prime essential towards successful results.

* Galloway, Bulletin 59, Mich. Experiment Station.

REMEDIES.

During the past two years experiments have been in progress under guidance of the Division of Mycology, Department of Agriculture, at Washington, the Experiment Stations of Wisconsin and Michigan. Trials were made at these places with certain chemical preparations, applied in the form of a spray—in the same manner that Paris green is used to check the ravages of the codlin moth. Beneficial results were obtained by the use of several compounds, but that known as “ammoniacal solution of copper carbonate” has in nearly every instance given the most encouraging returns. Professor Goff,* of the Wisconsin Agricultural Experiment Station, obtained by the use of this fungicide, when applied to apple trees of the Fameuse variety, the following results:—

| — | Per cent. in Fruit, First Quality. | Per cent. in Second Quality. | Per cent. in Third Quality. |
|---------------------|---|------------------------------------|-----------------------------------|
| Sprayed | 75.02 | 23.35 | 1.63 |
| Unsprayed | 23.34 | 53.89 | 22.71 |

Professor Goff used $1\frac{1}{8}$ oz. carbonate of copper, dissolved in 1 quart of ammonia, diluted with 22 gallons of water.

Professor Taft,† of the Michigan Agricultural Experiment Station, obtained results as follows, by the use of the same substance in the following proportions:—3 oz. carbonate of copper dissolved in 1 quart of ammonia and diluted with 22 gallons of water:—

| — | Per cent. Free from Spot. | Per cent. Slightly Spotted. | Per cent. Badly Spotted. |
|---------------------|---------------------------------|--------------------------------|-----------------------------|
| Sprayed | 51.2 | 48.6 | 0.6 |
| Unsprayed | 12.5 | 85.7 | 1.8 |

These results are very striking, and are worthy of careful consideration.

*Bulletin No. 23, Wisconsin Agricultural Experiment Station.

†Bulletin 59, Michigan Agricultural Experiment Station.

EXPERIMENTS CONDUCTED LAST YEAR.

It was in consideration of the above results that a series of experiments along this line were conducted at Abbotsford, Que., during the past season, on the farm of Wm. Craig & Son. I am indebted to Mr. Wm. Craig, jr., for his labour in superintending the work, and furnishing me with some of the facts upon which the following deductions are based.

I am also indebted to Mr. F. T. Shutt, Chemist to the Experimental Farms, for valuable assistance in planning the lines of experiments, and for the preparation of the copper carbonate and other necessary materials.

The trees selected were of the Fameuse variety, planted fourteen years ago on a loose, gravelly soil. During the past four years this orchard has not yielded more than 25, and often not even 10 per cent. of first-class apples.

Five rows in the centre of this orchard were selected, each row, which contained fourteen trees, being treated with a different mixture. A row of trees untreated was allowed to remain on either side of those operated upon. Four applications were made, one on each of the following dates: 14th and 26th June, and 17th and 29th July. At the time of the first application the fruit was about the size of garden peas.

When the fruit was picked it was divided into three grades, numbered, according to quality, first, second and third. The results are given in this way:—

Row 1.—Treated with

| | |
|-----------------------|----------|
| Copper carbonate..... | 1½ oz. |
| Ammonia..... | 1 qt. |
| Water..... | 22 gals. |

Result:

| | |
|--------------------|-----------|
| First quality..... | Per cent. |
| Second do | 33 |
| Third do | 25 |
| | 42 |

Row 2.—Treated with

| | |
|-----------------------|----------|
| Copper carbonate..... | 3 oz. |
| Water..... | 22 gals. |

Result:

| | Per cent. |
|--------------------|-----------|
| First quality..... | 50 |
| Second do | 25 |
| Third do | 25 |

Row 3.—Treated with

| | |
|----------------------|----------|
| Copper sulphate..... | 1 lb. |
| Ammonia..... | 1½ pts. |
| Water..... | 22 gals. |

This solution was too strong, injuring the leaves to such an extent as to cause half of them to drop within ten days from date of application. A second and weaker application had the same effect.

Row 4.—Treated with

| | |
|----------------------|----------|
| Copper sulphate..... | 1 lb. |
| Water..... | 22 gals. |

This had practically the same effect as the above, and was discontinued after a second application. It would seem with this result before us, that the ammonia did not increase the injurious effect of the copper sulphate.

Row 5.—Treated with

| | |
|--------------------------|----------|
| Hypsulphite of soda..... | 1 lb. |
| Water..... | 22 gals. |

No beneficial effect was noted, though the experiments on this row were rendered useless by severe inroads of the leaf-crumpler.

Row 6.—Untreated.

| | Per cent. |
|--------------------|-----------|
| First quality..... | 24 |
| Second do | 26 |
| Third do | 50 |

The time occupied in making each application, covering the 70 trees, was about 3½ hours with one man and boy and a horse. Of course, if the same mixture were used on the whole lot without any change, the time taken in making the application would be greatly reduced. As the cost of the application is much increased by the addition of ammonia in the copper carbonate mixture—while the results in the experiments cited above do not seem to warrant its use—it would appear that the copper carbonate and water mixture

in the strength as applied above could be used to advantage, and at a cost of about 1 cent per tree each application, or 5 cents for the season. This is an outside estimate even for large trees.

It is noteworthy to mention a fact which has attracted the attention of other investigators, viz., that the older leaves seem to be more sensitive to injury from most fungicides and insecticides, than the young and growing leaves. The later applications emphasized this observation.

The beginning of the work was unavoidably delayed until 14th June when the fruit was well formed, and in many cases had begun to show signs of the disease. There is no doubt had the treatment been commenced two or three weeks earlier the results would have been more favourable.

The most important point brought out in this work is that in connection with the use of the carbonate of copper in simple mixture or suspension with water.

This has been tried but one year, yet the results are sufficiently marked to lead me to ask that each fruit-grower who takes up this work should make a special test on at least a few trees, using the *carbonate of copper in suspension*.

FUNGICIDES RECOMMENDED.

The following mixtures are recommended:—

1. Ammoniacal copper carbonate—

| | |
|--------------------------|-----------|
| Carbonate of copper..... | 8 oz. |
| Ammonia | 1 gal. |
| Water. | 100 gals. |

HOW TO PREPARE.

In an ordinary vessel capable of holding a gallon or more, put 2 ounces of carbonate of copper and 1 quart of ammonia (ask your druggist for *strong ammonia*); when the copper is completely dissolved pour the mixture into a barrel and add 25 gallons of water. The solution is then ready for use.

Medium sized trees will take about 1 gallon each, and large trees from 1 to 2 gallons. A convenient method when using this formula is to prepare the carbonate of copper by dissolving it in the ammonia at once in the full quantity ordered above, and keeping it ready for use stored away in ordinary quart glass jars; these to be diluted with water as needed.

2. Carbonate of copper in suspension—

| | |
|--------------------------|-----------|
| Carbonate of copper..... | 2 oz. |
| Water..... | 25 galls. |

This is prepared for use in the same way as Paris green by mixing thoroughly with the water. A more evenly distributed mixture can be obtained by first stirring the carbonate of copper into one gallon of water, when well distributed this is poured into the remaining 24 gallons, and the whole thoroughly agitated. This mixture requires more care in application than the ammoniacal solution; it should be constantly agitated and laid on in a fine spray.

A COMBINED FUNGICIDE AND INSECTICIDE.

A series of experiments were conducted at the Central Farm last summer by the writer, assisted by Mr. Shutt, Chemist to the Experimental Farms, with a view to test the degree of strength which a combined fungicide and insecticide could be applied without injuring the leaves. The following are extracts from the summary of conclusions reached after several applications.

The quantities of chemicals given are on the basis of using 22 gallons of water, with ammonia as the solvent.

Carbonate of copper, 3 oz. in solution, Paris green, $1\frac{3}{4}$ oz. (proportion of 1 lb. to 200 galls. of water) caused a slight injury on the third application.

Carbonate of copper, $1\frac{1}{2}$ oz. in solution, Paris green, $1\frac{3}{4}$ oz. caused very slight injury after the third application.

Carbonate of copper, 3 oz. in suspension, Paris green, $1\frac{3}{4}$ oz. caused slight injury in later applications.

Carbonate of copper, $1\frac{1}{2}$ oz. in suspension, Paris green, $1\frac{3}{4}$ caused no injury.

RECOMMENDED FOR TRIAL.

In view of the above results I would therefore recommend for trial, to a limited extent, mixtures, as follows:—

| | |
|-------------------------------|-----------------------|
| (a.) Carbonate of copper..... | $1\frac{1}{2}$ oz. |
| Ammonia | $1\frac{1}{2}$ pints. |
| Water..... | 25 galls. |
| Paris green..... | $1\frac{1}{2}$ oz. |

The carbonate of copper should be dissolved in the ammonia, according to the directions already given, mixed with the water, and the Paris green then added, care being taken to stir in well, and keep it from settling to the bottom.

| | |
|-------------------------------|-----------|
| (b.) Carbonate of copper..... | 1½ oz. |
| Paris green..... | 1¼ oz. |
| Water..... | 25 galls. |

The experiments made with this mixture thus far, do not warrant me in speaking positively in regard to its efficacy, but they show that no injury to the foliage resulted from the application of a stronger mixture than the one here recommended for trial. If this proves an effective remedy for the codlin moth as well as the "apple spot" it will no doubt supersede any other now in use, both on account of the ease with which it can be prepared, as well as its comparative cheapness. The Paris green can be omitted after the second application in mixtures (a) and (b), as two sprayings of Paris green is generally considered a sufficient remedy for the codlin moth.

HOME MANUFACTURE OF COPPER CARBONATE.

As the precipitated form of carbonate of copper is not always obtainable from druggists, directions are herewith appended for the easy preparation of this material at a cost much less than the usual wholesale price.

In a vessel capable of holding two or three gallons, dissolve 1½ pounds of copper sulphate (blue vitriol) in 2 quarts of hot water. This will be entirely dissolved in fifteen or twenty minutes, using the crystalline form. In another vessel dissolve 1¼ pounds of sal soda (washing soda) also in 2 quarts of hot water. When completely dissolved pour the second solution into the first, stirring briskly. When effervescence has ceased fill the vessel with water and stir thoroughly; then allow it to stand five or six hours, when the sediment will have settled to the bottom. Pour off the clear liquid without disturbing the precipitate, fill with water again and stir as before; then allow it to stand until the sediment has settled again, which will take place in a few hours. Pour the clear liquid off carefully as before, and the residue is *carbonate of copper*. Using the above quantities of copper sulphate and sal soda, there will be formed 12 ounces of copper carbonate.

Instead of drying this, which is a tedious operation, add four quarts of strong ammonia, stirring in well, then add sufficient water

to bring the whole quantity up to 6 quarts. This can be kept in an ordinary two gallon stone jar which should be closely corked.

FORMULA.

Each quart will contain 2 ounces of the carbonate of copper, which when added to 25 gallons of water, will furnish a solution for spraying, of the same strength and character as that obtained, by the use of the dried carbonate, and one which can be prepared with little labor, and kept ready for use throughout the season.

CARBONATE OF COPPER IN SUSPENSION.

When the carbonate is to be used in suspension, instead of adding the ammonia to the sediment, add water until the whole quantity is made up to 6 quarts. Stir this thoroughly until the sediment is completely suspended (entirely mixed throughout) and pour the thick liquid into a suitable jar, when it will be ready for use.

Before using shake the contents thoroughly, so that all the sediment may be evenly distributed in the water. Pour out a quart of the thick fluid and mix with 25 gallons of water.

The cost of the chemicals will vary with the amount purchased. Copper Sulphate (blue vitriol) is usually retailed at from 10 to 12 cts. per pound, and Sal Soda (washing soda) at about 3 cts. per pound. The strong ammonia should be used which can be bought in half gallon jars at from 20 to 25 cents per pint.

WHEN TO SPRAY.

The importance of early treatment cannot be too strongly urged, as after the disease has gained foothold and is working within the tissues, remedies which can only be applied externally are of very little use. The first application should be made *before the blossoms open*; the second soon after they have fallen, the third and fourth following in periods of about ten days or two weeks apart. If the season is cool and wet, a fifth application will be necessary, but if moderately dry, four applications, if begun in good time, will in all probability be sufficiently effective.

HOW TO APPLY THE FUNGICIDE.

1. For orchard work use some form of a barrel pump.
2. Use nozzles which will distribute the liquid in a fine misty spray.

3. The trees do not need to be drenched, but must be completely moistened with the mixture.

4. Reliable pumps are manufactured by the Field Force Pump Co., Lockport, N.Y., Gould Manufacturing Co., and Rumsey & Co., both of Seneca, N.Y., and the Nixon Nozzle and Machine Co. of Dayton, Ohio.

I am not aware that these pumps are manufactured in Canada.

MILDEW OF THE GRAPE.

The disease particularly referred to in the following is known among viticulturists as "downy mildew," "brown" or "gray rot" of the grape, and to scientists as *Peronospora viticola*, was very severe last year in many grape growing districts. It has been particularly destructive in the Eastern and Central States, and also in Western Ontario. Last year it was prevalent in vineyards in the Province of Quebec, and also in the Ottawa Valley.

As a rule it is first noticed on the fruit—when about half formed—presenting a downy and frosted appearance, which gives place to a grayish brown in the later stages. The berries shrivel and fall to the ground when slightly shaken. Beginning with one or two varieties in the vineyard, the disease if allowed to run its course will spread rapidly, attacking other kinds which were at first entirely exempt.

It usually affects the leaves and wood later in the season, sometimes in the case of early varieties after the fruit has been gathered. This stage of the disease was prominent as affecting the Roger Hybrids in the Experimental Farm vineyard last season.

At first it is seen on the upper surface of the leaf showing in brown spots, while the lower surface presents the frosted appearance resembling that form of the disease affecting the fruit. This particular leaf form is not easily detected on grapes having the thick pubescent leaves characteristic of the Concord family.

TREATMENT.

| | |
|--------------------------|----------|
| Carbonate of copper..... | 2 oz. |
| Ammonia..... | 1½ pint. |
| Water..... | 25 gals. |

As soon as the mildew made its appearance last year on our vines they were thoroughly sprayed with the above mixture. Two applications and the removal of all diseased berries had the effect of checking the spread of the malady, but at the same time demonstrated—when compared with the results of my former experiments—that the proper line of treatment leading to complete success, lies in the *early application* of the remedy.

The following is the course of treatment planned for the vineyard of the Experimental Farm this season :

1. All prunings, leaves, etc., to be carefully burned.
2. When vines are uncovered spray them—including the posts and trellises—with a simple solution of copper sulphate (blue vitriol) 1 lb, dissolved in 15 gallons of water.
3. Spray with the ammoniacal copper carbonate using the formula already given soon after the fruits sets ; make two or three additional applications at intervals of ten days or two weeks as the necessities of the case seem to demand.
4. Remove and destroy diseased parts of the fruit and foliage.

GOOSEBERRY MILDEW.

The great draw back to the successful cultivation of the European gooseberry in Canada has been the annual loss occasioned by the prevalence of this disease (*Sphaerotheca mors-uvae* B. & C.) The external appearance of the fungus is well known, showing on the young woods, leaves and fruit as a whitish downy coating, usually appearing soon after the leaves have fully expanded.

TREATMENT.

Successful results are reported by Prof. Goff of the Agricultural Experiment Station of Wisconsin, by the use of Potassium Sulphide (liver of sulphur) at the rate of 1 ounce dissolved in four gallons of water. Spraying was commenced when the leaves were partly expanded, and repeated seven or eight times during the summer.

Without actual experiment it would not be wise to recommend the unrestricted use of any remedy for this disease, but from our present knowledge of the general efficacy of the ammoniacal copper carbonate, it seems safe to advise a trial at any rate, of this remedy in the same proportions as those given for the apple and grape.

The effect on the foliage of the first application should be carefully noted, and if at all injurious the amount of copper carbonate, should be lessened to $1\frac{1}{2}$ ounces.

A REQUEST.

All persons who are interested in, and take up any of these lines of experiment are earnestly requested to forward me as soon as practicable the results of their work, together with such notes explanatory of the conditions affecting the trials, as shall aid me in forming correct conclusions in regard to the value of these remedies.